

AUSTRALIAN PALEOFLOOD SYSTEMS: A NEW EARTH ANALOGUE FOR MARTIAN CHANNELS.

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Introduction: Researchers have speculated on the occurrence of surface water flows on Mars since Mariner 9 first revealed that large portions of the surface contained channel-like features (1, 2). While the source and release mechanisms of the large volumes of water are still subject to discussion, investigators attribute most of these channel forms to the geomorphic effects of catastrophic floods (2, 3, 4). Earth analogs have been used in attempting to understand the channeled features on Mars, such as the comparison to landforms produced by the catastrophic Missoula and Bonneville floods (5, 2; 6; 7) and deep sea turbidity currents and canyons which reveal channel behavior under reduced gravitational forces (8). Central Australian catchments provide an additional and different Earth analogue which will be particularly useful in understanding the flood processes, forms and deposits of unconfined river systems that occupy the hypothesized flood terrain on Mars. Funding for this research will begin in May 1999 and is provided by the Mars Data Analysis Program.

The primary significance of this work will be an improved understanding of unconfined fluvial processes on Mars and on Earth and the focus will be to develop a series of geomorphic signatures that identify deposits emplaced by these processes. Most existing literature on high magnitude flood processes focuses on the bed-rock gorge reaches of rivers where fluvial features are related to the discharge magnitude (e.g., 3, 9, 10). We intend to document the primary attributes of deposits and landforms found on the broad plains downstream from the confined reach of flooded rivers, utilizing both field results from central Australia (11) and remote sensing characteristics of these areas (Figure 1). This new information will be applied to locations below the mouths of channels on Mars, where once again most existing literature deals with the confined channel landforms rather than the deposits outside of the channel reach (e.g., 12, 7, 13). We believe that this approach will allow us to test the flood hypothesis for Martian channels in areas not utilized for this purpose in most previous efforts. The joint analysis of both terrestrial and Martian flood-related deposits should advance our understanding of flood events that have occurred on both planets. Another potential implication of this project is the identification of locations where possible evidence of life on Mars may be preserved. Alluvial deposits and nutrients in arid central Australia tend to move together (14), resulting in abrupt ecological boundaries that match different geomorphic environments (15). Similar associations may have occurred on Mars so that the identification of these potential

biologically rich paleo-environments on Mars could be important for the assessment of future landing sites.

Central Australia: The proposed study area is located in arid central Australia (23° to 26° S, 138° to 132° E). This location has important similarities to the Martian landscape in terms of its arid climate, the slow land surface process rates and ancient history of its landforms, low elevation, low sediment yield, the occurrence of high magnitude paleofloods and the extensive reworking of fluvial deposits by aeolian processes. In addition, all catchments that drain the study area have unconfined channel reaches that terminate in the desert.

Martian Channels: Since their discovery, the channels on Mars have generated both great interest and considerable discussion. While there are many alternatives proposed in the literature for the eroding fluid that formed the channels, water remains the most widely accepted geological fluid (13). The two most probable causes for Martian floods are massive release of groundwater and draining of surface lakes (13). Previous classification schemes have focused on confined rather than unconfined reaches, the latter may be similar to previously identified planar fluvial features (16). Unconfined channels and floodouts are associated with the mouths of channels and downstream from ponded areas where few obstacles confine flow.

Channels are widely distributed about Mars (17), although the large ones identified as outflow channels tend to concentrate around the Chryse basin southern rim. The Chryse basin is thus our primary target for searching for possible floodouts on Mars. We will certainly examine the setting below the mouths of Ares and Tiu Valles, where Pathfinder provides surface information, as well as Maja and Kasei Valles which may have contributed to materials around the Viking 1 site (18). The next target will be in the Isidis basin, where numerous unnamed channels run through the Libya Montes that compose the southern rim of the basin (Fig. 2). A third candidate area we would examine is the mouth of Ma'adim Vallis, which flooded Gusev crater (19).

Methodology: Mapping of selected areas in central Australia and near Martian channels is the principal methodology of this project. A similar approach was applied to paleoflood deposits of the Todd River in central Australia where interpretations were evaluated by extensive ground-truthing (11). The project builds upon the previous study, utilising the extensive sampling and field information available.

Thematic Mapper (TM; 30 m/pixel) and Multi-Spectral Scanner (MSS; 80 m/pixel) images of central Australia, will comprise the primary remote sensing data set for the Australia study. Patterns of vegetation and soil properties can be derived from standard multi-spectral image analysis techniques. Landform morphology associated with paleoflood landforms differ from surrounding aeolian forms at scales larger than the image resolution (Fig. 1), ensuring that the central Australian landscape is an excellent location for this form of analysis (11). Large-scale morphological characteristics to be mapped include channel patterns and bedforms, the spatial extent of flows, the boundary surfaces with pre-existing topography, and the aeolian reworking of the terminal deposits.

Mapping of features on Mars will follow standard geologic and geomorphic techniques used in planetary geology (20). We intend to investigate sites on Mars where the potential is high for the emplacement of deposits comparable to the Australian floodout features. We intend to use Viking data as the basis for evaluation of candidate floodout locations. Although coverage is spotty, Viking images with better than 50 m/pixel resolution are widely distributed around the planet (21) and we will look at each high-resolution Viking frame on or near the candidate site as part of our evaluation. It is unlikely that a MOC image will fortuitously include a candidate floodout area, but once we have identified the best candidate sites, we will provide the locations to the MOC team for consideration in target-planning. We will be looking for both landforms associated with unconfined fluvial emplacement, and for physical (i.e. local gradients and relief (MOLA)) and/or chemical properties (compositional indicators of highland affinities in sediments (TES)) that might provide information on flow emplacement.

References: [1] Masursky, H. (1973), *J. Geophys. Res.* 78, 4037-4047. [2] Sharp, R.P. and M.C. Malin (1975), *Geol. Soc. Am. Bull.* 86, 593-609. [3] Baker, V.R. (1982), Univ. of Texas Press, Austin, 198 p. [4] Baker, V.R. et al. (1992) In H.H. Kieffer et al., 493-522, Univ. of Arizona Press, Tucson. [5] Baker, V.R. and Milton, D.J. (1974) *Icarus* 23, 27-41. [6] Baker, V.R. (1978), *Proc. Lunar Planet. Sci. Conf.* 9th, 3205-3223. [7] Baker, V.R. and R.C. Kochel (1978) *Proc. Lunar Planet. Sci. Conf.* 9th., 3193-3203. [8] Komar, P.D. (1979), *Icarus* 37, 156-181. [9] Wohl, E.E. (1992) *Geol. Soc. Am. Bull.* 104, 770-778. [10] Wohl, E.E. (1992), *Earth Surf. Proc. Landforms* 17, 69-84. [11] Bourke, M.C. (1999) Ph.D. Thesis, Australia National University, Canberra. [12] Masursky, H., et al. (1977), *J. Geophys. Res.* 82, 4016-4038. [13] Carr, M.H. (1996) Oxford Univ. Press, Oxford, 229 p. [14] Pickup, G. (1985),

Austral. Rangeland J. 7(2), 114-121. [15] Stafford-Smith, D.M. and S.R. Morton (1990) *J. Arid Environ.* 18, 255-278. [16] DeHon, R.A. (1992), *Earth Moon Planet.* 56, 95-122. [17] Carr, M.H., and G.D. Clow (1981), *Icarus* 48, 91-117. [18] Tanaka, K.L. (1997), Mars, *J. Geophys. Res.* 102(E2), 4131-4149. [19] Cabrol, N.A., et al (1996), *Icarus* 123, 269-283. [20] Wilhelms, D.E. (1990) In R. Greeley and R.M. Batson 208-260, Cambridge Univ. Press, Cambridge. [21] USGS (1983) *U.S. Geological Survey*, Flagstaff, Arizona.

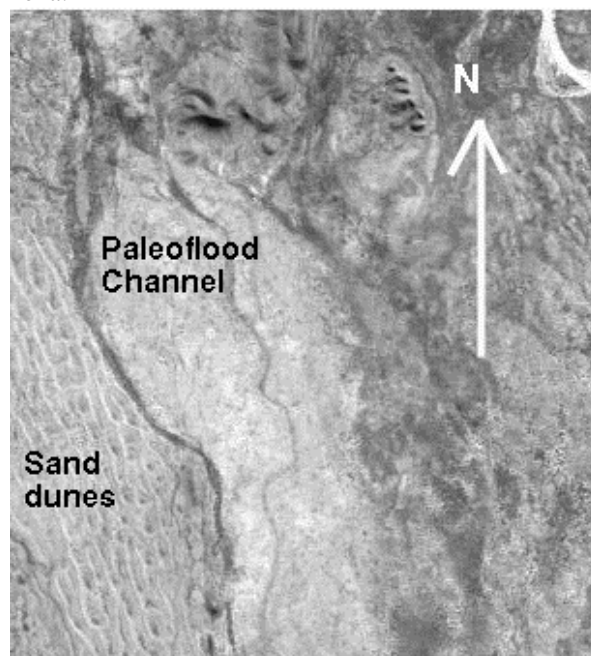


Figure 1. Enhance TM image of a paleoflood channel in the Todd River catchment in central Australia. The unconfined channel is 2-4 km wide, composed of gravelly sand and has laterally eroded 6 m high aeolian dunes.

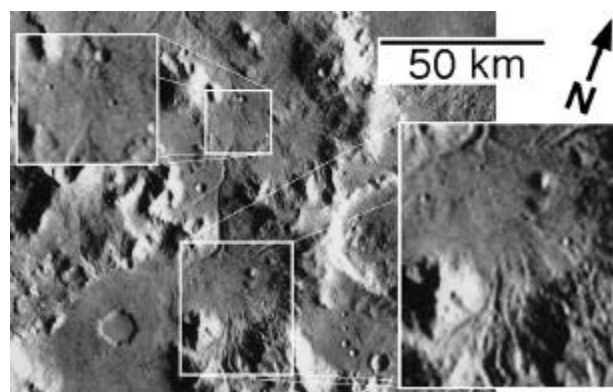


Figure 2. Mosaic of portions of Viking Orbiter image 377S77 showing an unnamed channel in the Libya Montes south of Planatia. 2X enlargements of two reaches show confined channels opening onto flat terrain. 230 m/pixel, 0.5°N, 277.5°W.